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ABSTRACT

This training manual provides information needed to meet the minimum EPA standards for certification as a commercial applicator of pesticides in the demonstration and research pest control category. The text discusses pesticide-organism interactions such as penetration, transport, accumulation, and biological magnification. Integrating pesticides with other control practices is also presented. (CS)

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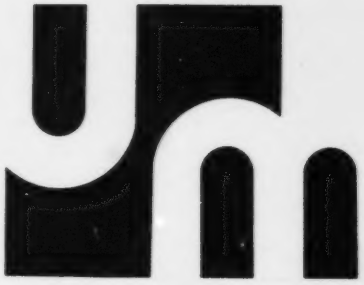

DEMONSTRATION AND RESEARCH PEST CONTROL

manual 91

This manual was developed in cooperation with The Missouri Department of Agriculture and the Coop Extension Service, University of Missouri.

Assembled by Members of Extension Pesticide Training Team.

SE 024 607

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This training manual is intended to provide information needed to meet the minimum standards of the Environmental Protection Agency. It is also intended to prepare you to take an examination for pesticide certification given by the Missouri Department of Agriculture based on this manual. This training will not provide all the information needed for effective Demonstration and Research Pest Control. Additional information in the form of publications and short courses can be obtained from the University Extension Centers.

This material was adapted to Missouri conditions from materials developed by the University of Georgia.

DEMONSTRATION AND RESEARCH PEST CONTROL

Individuals in the Demonstration and Research Pest Control Category not only provide and disseminate information on pest control, but serve as examples for other applicators. Therefore, they should be particularly knowledgeable in pesticide use and other methods of pest control. And they should demonstrate competence in safe and effective use of pesticides. They must also understand pesticide-organism interactions and recognize the importance of integrating pesticide use with other control measures in effective pest management. For example, cultivation is often needed to supplement the benefits of herbicides. Crop rotation helps to reduce the natural increase of many insects and disease-causing organisms, thereby decreasing the need for higher levels of pesticides to control certain pest populations.

The Demonstration and Research Pest Control Category includes: (1) people who demonstrate to the public the proper use and techniques of applying restricted use pesticides or supervise such a demonstration, and (2) persons conducting field research with pesticides, and in doing so, use or supervise the use of restricted use pesticides.

The first group includes Cooperative Extension specialists and county agents, vocational agriculture instructors, state college instructors, industry representatives demonstrating pesticide products, and others who demonstrate methods used in public programs.

The second group includes State, Federal, commercial or industry scientists, and other persons conducting field research using restricted use pesticides.

People applying for certification under the Demonstration and Research Pest Control Category will be responsible for the information contained in "A Guide for Commercial Applicators," the manual prepared by the U. S. Environmental Protection Agency. The manual covers general information on: Pests, Pest Control, Pesticides, Labels and Labeling, Using Pesticides Safely, Application Equipment, Laws and Regulations.

In addition, demonstrators will be responsible for information contained in one or more of the nine category manuals that will be appropriate for their particular activity.

Testing for certification is the responsibility of the Department of Agriculture.

REQUIREMENTS FOR CERTIFICATION

Special Standards of Competency. Persons demonstrating the safe and effective use of pesticides to other applicators and the public will be expected to meet comprehensive standards reflecting a broad spectrum of pesticide uses. Many different pest problems encountered in the course of demonstrations require practical knowledge of problems, pests, and the population levels that occur in each demonstration situation. Further, demonstrators must understand pesticide-organism interactions and the importance of integrating pesticide use with other control methods.

In general, applicators doing demonstration pest control work should possess a practical knowledge of all the standards in Section 171.4 (b) of the Federal Insecticide, Fungudice and Rodenticide Act. This would include:

1. Understanding labels and labeling
   a. The general format and terminology of pesticide labels and labeling.
   b. Classification of the product, general or restricted.
   c. Necessity for use consistent with the label.

2. Safety factors including:
   a. Pesticide toxicity, the hazards to man and common exposure routes.
   b. Common types and causes of pesticide accidents.
   c. Precautions necessary to guard against injury to applicators and other individuals in or near treated areas.
   d. Need for and use of protective clothing and equipment.
   e. Symptoms of pesticide poisoning.
   f. First aid and other procedures to be followed in case of a pesticide accident.
   g. Proper identification, storage, transport, handling, mixing procedures and disposal methods for pesticides and used pesticide containers, including precautions to be taken to prevent children from having access to pesticides and pesticide containers.

3. Environment--The potential environmental consequences of the use and misues of pesticides may be influenced by such factors as:
   a. Weather and other climatic conditions.
   b. Types of terrain, soil structure or soil type.
   c. Presence of fish, wildlife and other non-target orgamisms.
   d. Drainage patterns.

4. Pests--Factors such as:
   a. Common features of pest organisms and characteristics of damage needed for pest recognition.
   b. Recognition of relevant pests.
   c. Pest development and biology when relevant to the problem identification and control.

5. Pesticides--Factors such as:
   a. Types of pesticides.
   b. Types of formulation.
   c. Compatibility, synergism, persistence, and animal and plant toxicity of the formulations.
   d. Hazards and residues associated with use.
   e. Factors which influence effectiveness or such problems as resistance to pesticides.
   f. Dilution procedures.

6. Equipment--Factors including:
   a. Types of equipment and advantages and limitations of each type.
   b. Uses, maintenance and calibration.

7. Application Techniques--Factors including:
   a. Methods of procedure used to apply various formulations of pesticides, solutions, and gases, together with a knowledge of which technique of application to use in a given situation.
   b. Relationship of discharge and placement of pesticides to proper use, unnecessary use, and misuse.
   c. Prevention of drift and pesticide loss into the environment.

8. Laws and Regulations--Applicable State and Federal laws and regulations.

In addition, persons in demonstration activities shall meet the specific standards required for the following categories when they apply to their particular activities:

1. Agricultural pest control
    a. Plant
    b. Animal
2. Forest Pest Control
3. Ornamental and Turf Pest Control
4. Seed Treatment
5. Aquatic Pest Control
6. Right-of-way Pest Control
7. Structural Pest Control
    a. General
    b. Termite
    c. Fumigation

Depending upon their particular activity, persons conducting field research or method improvement work with restricted use pesticides should be expected to know the standards for the categories 1 - 7 above that apply to their particular situation, plus the following categories:

8. Public Health Pest Control, and
9. Regulatory Pest Control.

Manuals on these topics are available from the Publications Office, 205 Whitten Hall, University of Missouri-Columbia 65201.

PESTICIDE-ORGANISM INTERACTIONS

Both the beneficial and harmful effects of pesticides are determined by pesticide-organism interactions, or how pesticides and organisms react to each other. To do its job, a pesticide must usually penetrate the organism, move or be transported to the site of action and there disrupt or alter a vital function. The manner in which

the pesticide affects the vital function is called its mode of action. Penetration, transport, and mode of action involve pesticide-organism interactions. Pesticide-organism interactions are also involved in the metabolism, accumulation and elimination of pesticides by the organism as well as in biodegradation and biological magnification.

Selectivity (the ability of a pesticide to kill or otherwise alter one organism and not another) and the development of pesticide resistance are often causes by differences in pesticide-organism interactions.

Penetration. The speed and extent of penetration depends on the permeability of certain tissues of the organism to the specific pesticide. This permeability differs significantly among organisms and even among different tissues of the same organism. Among animals, tissues of the respiratory and digestive system are usually much more permeable than the skin. With plants, mature tissues and specialized tissues such as bark generally provide more effective barriers than new and succulent growth. The ability of a pesticide to penetrate into an organism depends on its chemical nature and the formulation. Penetration is usually increased by organic solvents.

Transport. The movement of the pesticide from the place where it entered the organism to the site of action involves the mobility of the pesticide molecule, the efficiency of the transporting mechanism of the organism, and the effect of each on the other.

Mode of Action. The pesticide performs its main function only after it reaches the site of action within the organism. This is usually the protoplasm of a living cell, and often a particular kind of cell. For example,

the site of action for organophosphate insecticides is the nerve cell.

Pesticides kill or otherwise alter an organism by disrupting or interfering with some vital physiological function. This is called the pesticide's mode of action. As an example, the mode of action of organophosphate insecticides is the inhibition of cholinesterase, an enzyme that is essential in regulating the nervous system. When cholinesterase is inhibited, muscles and glands become extremely overactive because of excessive stimulation by the nerve cells, causing the insect to die from overstimulation.

Metabolism. Metabolism is the process by which a pesticide, or another chemical, is changed into one or more different chemicals within a living organism. The metabolic product, or metabolite, may be either more toxic or less toxic than the original pesticide chemical. Some pesticides are effective only after they have been metabolized to a lethal compound by the organism. Given enough time, most organisms can metabolize most pesticides to non-toxic metabolites. Survival of the organism may depend on whether or not the organism can metabolize the pesticide into non-toxic metabolites before the toxic activity is complete or irreversible.

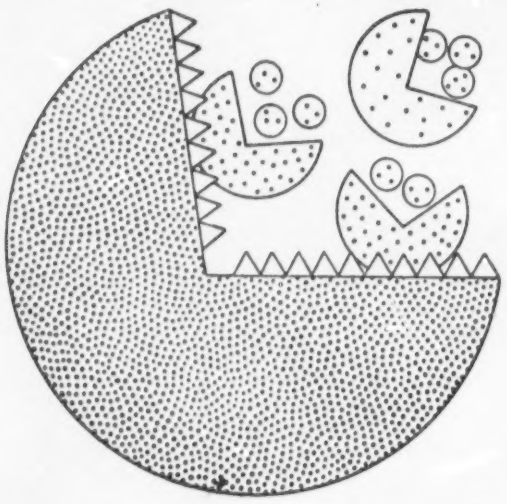
Accumulation and Elimination. Pesticide chemicals and their metabolites may be stored or accumulated within the organism or be eliminated as waste. If the level of exposure to most accumulative pesticides remains constant, the organism will reach an equilibrium between storage, metabolism, and elimination. Therefore, the concentration of the pesticide and its metabolites will remain constant within the organism. If the level of exposure is changed, then the concentration within the organism

will correspondingly increase or decrease.

Biogradation. Pesticides in the environment can be destroyed physically by ultraviolet light and chemical reactions. But pesticide-organism interactions are involved when they are biodegraded. Biodegradation is simply a form of metabolism. It refers to the decomposition of a pesticide residue in the environment by bacteria and/or other microorganisms that use it for their nutrition.

Biological Magnification. Biological magnification is an interesting pesticide-organism interaction. It is the tendency for certain pesticides to progressively become more concentrated in each type of organism when moving from the bottom to the top organism within a food chain. DDT is a notable pesticide example.

DDT in Lake Michigan is probably one of the bext examples of biological magnification. For example, the bottom sediments were found to contain an average of 0.0085 ppm.



Certain pesticides progressively become more concentrated as they move upward in the food chain. For instance, the small circles represent pesticide buildup in small invertebrates; the small pie-shapes, the buildup in lake trout; and the large shape, the buildup in herring gulls.

Small invertebrates averaged 0.41 ppm. (b) while predators such as coho solmon and lake trout contained 3 to 8 ppm. Herring gulls, at the top of the food chain, contained as much as 3177 ppm of DDT. In this case, the overall magnification from the bottom sediment is about 370,000 fold.

Biological magnification has allegedly resulted in deaths and reproductive failures among predatory animals, especially hawk-like birds and brown pelicans. Perhaps the most familiar example of reproductive effects is the association of thin egg shells with certain organochlorine insecticides.

Consequently, awareness of various pesticide-organism interactions is important in studying and reporting pest managements methods.

INTEGRATING PESTICIDES WITH OTHER CONTROL PRACTICES

Properly planned and executed, integrated pest management practices can maintain pest populations at a level low enough to satisfy human needs with minimal adverse effects on non-target organisms and on environmental quality. Integrated pest management can be more effective if the agricultural crop, for example, is considered in its entirety and not merely an arena in which to embattle a pest. Past, present and future conditions or practices significantly affect the level of pest populations, the choice of pest control methods, and the degree of pest control achieved. A typical experience in corn production was the development of resistance to certain soil insecticides by the western corn root worm. Crop rotation, supplemented by different insecticides, became necessary. In addition, plant breeders developed hybrids with more vigorous root systems.

Naturally, any pest control practice, including the application of pesticides, will have effects other than the intended one. Such side effects may be good or bad, gross or slight, short-lived or long-lived, local or distant, obvious or subtle. The Demonstrator and Researcher should be ever observant for these side effects and consider them in reporting, demonstrating, and recommending pest control practices.

The essence of integrated pest management is to select those pest control measures that will maximize beneficial effects and mininimize harmful ones. Individual elements, or control measures, within the integrated pest management program should be selected, used in the proper sequence, and

timed to be compatible with each other. For example, careful computerized studies of the life cycles of certain apple diseases were correlated with weather conditions in Michigan and other fruit growing states. They found it was possible to extend the time between fungicide applications, in some cases resulting in significant reductions in the spray schedules. Control measures should also be correlated with other cultural or maintenance practices and uses for instance. Observations and evaluations of the effects on target and non-target organisms are extremely important. For pesticides and other control measures can be overused to the extent that they lose their effectiveness, interfere with the benefits of other control measures, or adversely affect man, other

non-target organisms, or the environment.

Pesticides are probably more prone to being overused or misused than the other pest control methods. Not only can such misuse cause unnecessary hazard to man and his environment, but sometimes it can result in poor pest control--or even a higher incidence of pest attack.

Resurgence of target pest populations or population explosions among secondary pests or non-target pests may follow certain pesticide applications because the pesticides destroyed the pests natural enemies. For instance, amphids and mites frequently thrive after aphislions, lady beetles, syrphid fly larvae or other natural enemies are destroyed by a pesticide application. Usually this occurs after applying pesticides that are not effective against aphids or mites. But in some instances the pesticides were applied precisely for aphid or mite control, and yet the targer populations have resurged.

Parasite and predator populations may survive a pesticide application but be decimated by starvation when the pests and other hosts are killed. For this reason, the apple rust mite is allowed to survive at moderate populations early in the season in the integrated control of apple mites in Michigan so that it will support predators that can later feed on spider mites.

In certain instances, an organism is not an important pest simply because another organism competes with it. However, at times such an organism becomes a pest when its competition is removed. If broadleaf weeds are selectively killed by a herbicide, grassy weeds will usually thrive. Some pests that occur on crops late in the season are pests because the crop has been protected from the pests competitors. The pecan weevil would be no problem during most seasons if pecan nut destroyers such

as pecan nut casebearers and pecan scab were not controlled.

In some instances, a pest may be supporting another organism that can become a pest when its host is controlled. Weeds may harbor insects such as plant bugs and certain caterpillars that move to cultivated crops when the weeds are destroyed. Weed hosts can also harbor disease-causing organisms and the insect carriers that can transmit them. Fleas may move from dead rats to humans or pets.

The certified applicator in demonstration and research pest control must be ever mindful of the extreme complexity of the environment in which pest control is practiced. Biological phenomena, climate, topography, various physical and chemical characteristics, maintenance or cultural practices, and use patterns are so interrelated that it is extremely difficult to adequately assay the effects that a pesticide may have on the ecosystem. One must be constantly alert and thoughtful in developing, recommending, and demonstrating pest control practices.

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1. Category Manual:
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